TeleMed: Development of a Java/CORBA-based Virtual Electronic Medical Record

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Outline:
Bringing Distributed Computing to the Real World

- **Importance of a Wide Area Component Architecture for Healthcare**
- **TeleMed Secure, Collaborative Example**
- **Lessons learned**

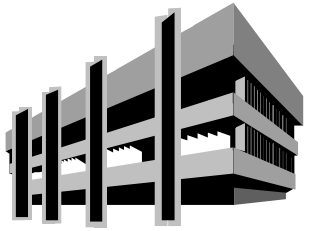
Why Los Alamos?

- **Long term experience in distributed and parallel high performance computing**
  - **Wide area teraflop computing for modeling and simulation**
  - **Distributed object technology is crucial component of meeting the goals**
- **Non-proprietary prototyping**
  - **Assist agencies and organizations in solving their problems**
  - **Help create a vision and work with industry to achieve it**
- **The Dept of Energy needs to manage its health risks**

Value of developing advanced healthcare internet standards

- Improve the quality and reduce the cost of healthcare nationally and internationally
- Leverage tools with industry to help us solve important problems
- Bring distributed computing to a stove-pipe industry
- Enable access to High Performance Distributed Computing (HPDC) for clinical decision support

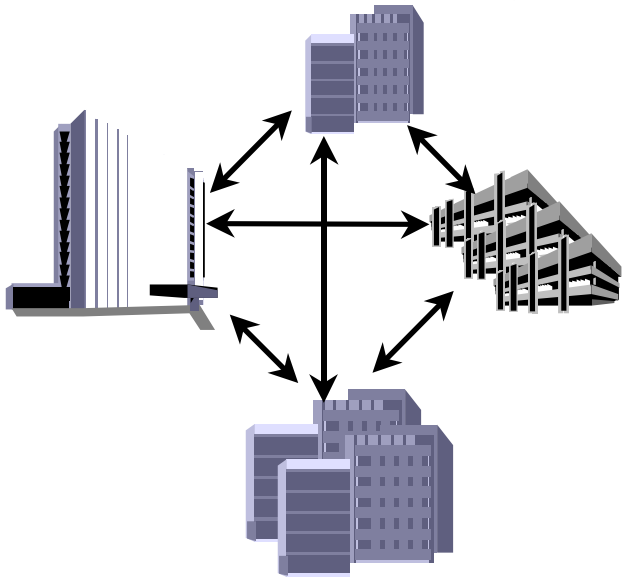
IDN: The Dominant Healthcare Trend



3000 US
Hospitals (1996)

600 US
IDNs (2005)

768 hospital acquisitions
and mergers in 1996 (AHA)



Managed Care is Driving the Health Care Industry to form Integrated Delivery Networks

The Paper Record Dilemma

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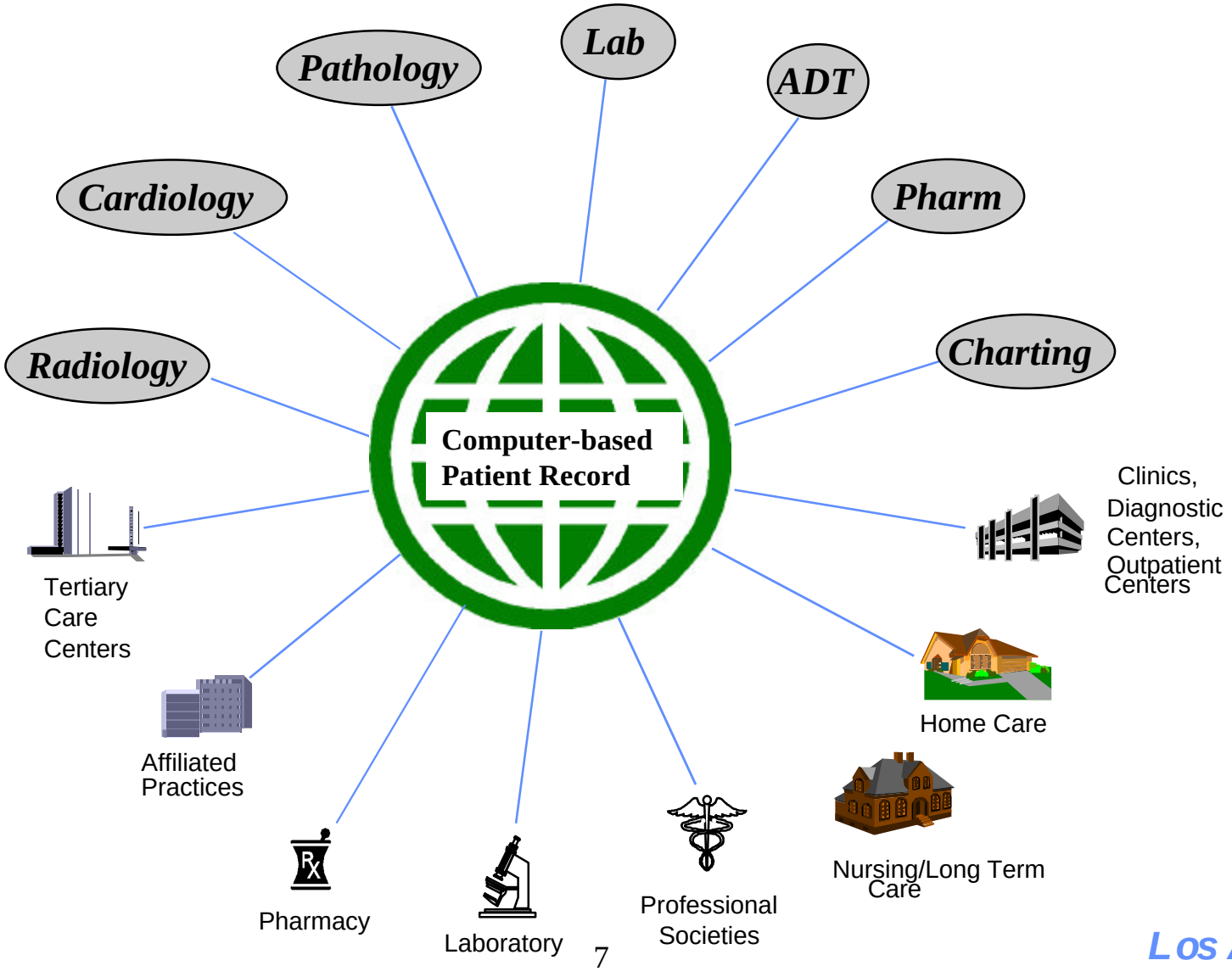
The Computer-based Record Solution



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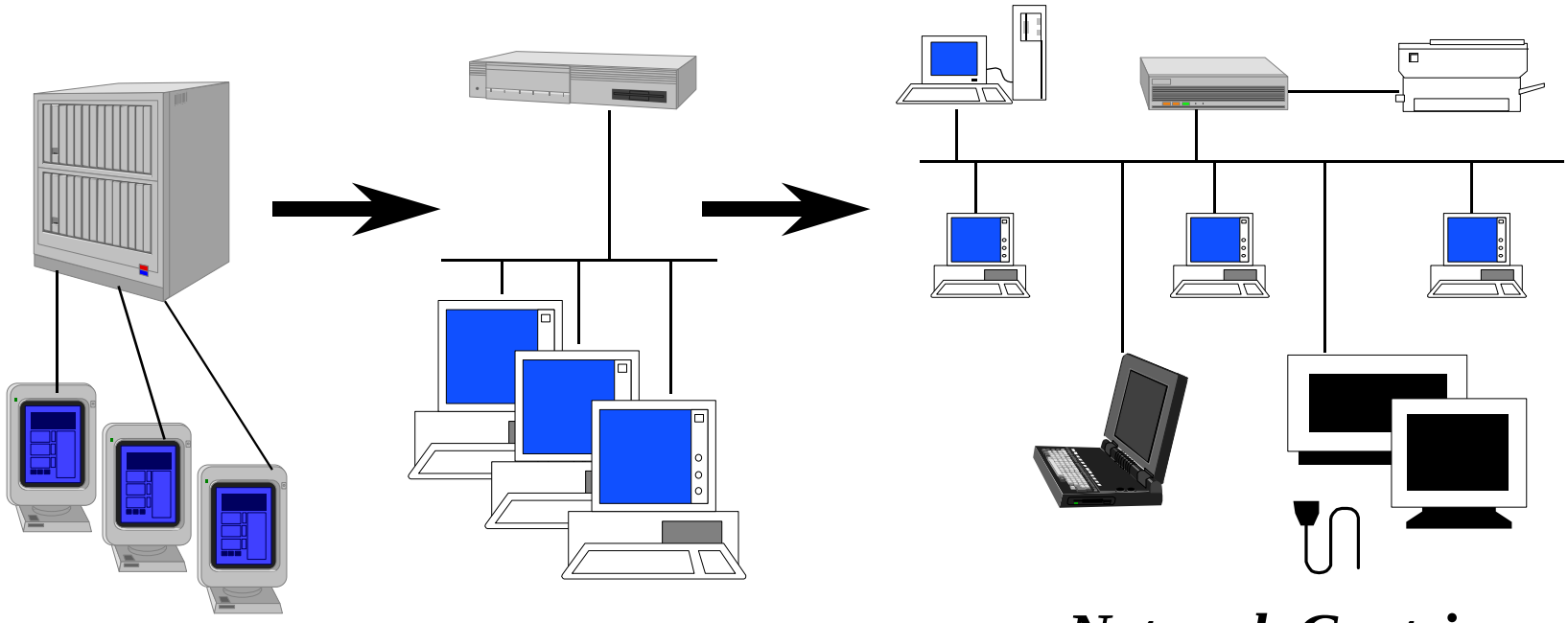
Technology Trends

1970's *1980's* *1990's*



Main Frame *Client/Server* *Network Centric Distributed Computing*

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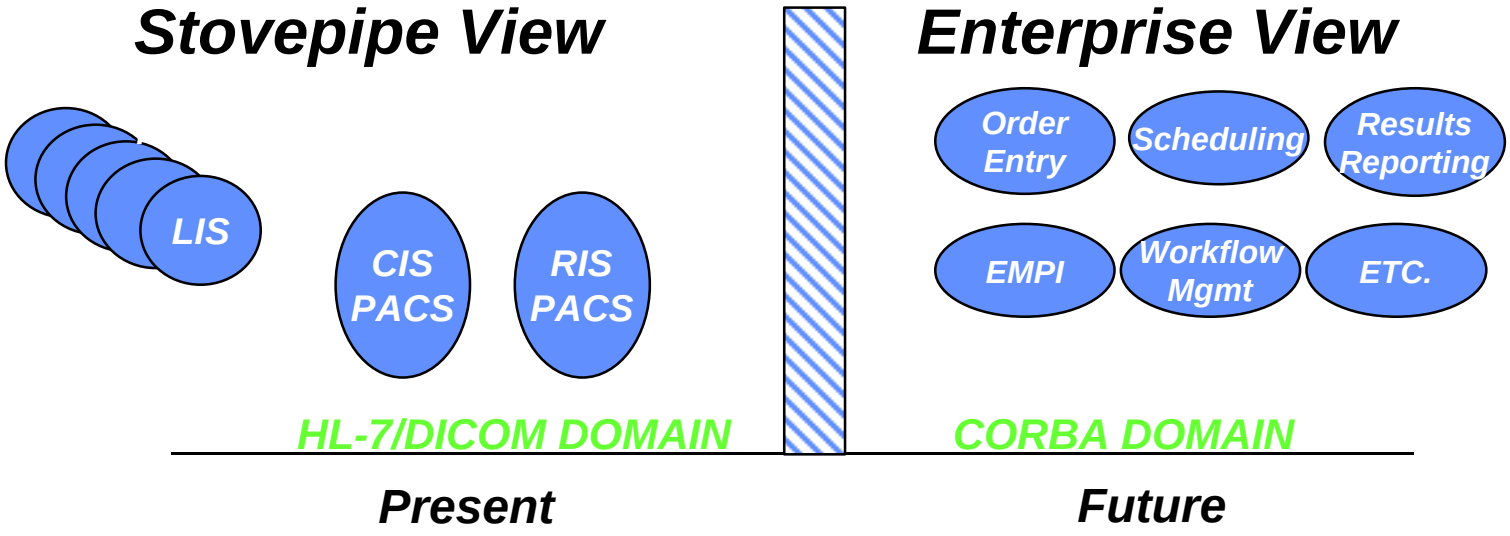
IT Paradigm Shift under Managed Care

Managed Care Means Managed Information:

Enterprise-wide longitudinal CPR (40 %)
Enterprise-wide Scheduling (40%)
(Survey by Modern Healthcare, Feb 1997)

Master Patient Index (37%)
System-wide access (33%)



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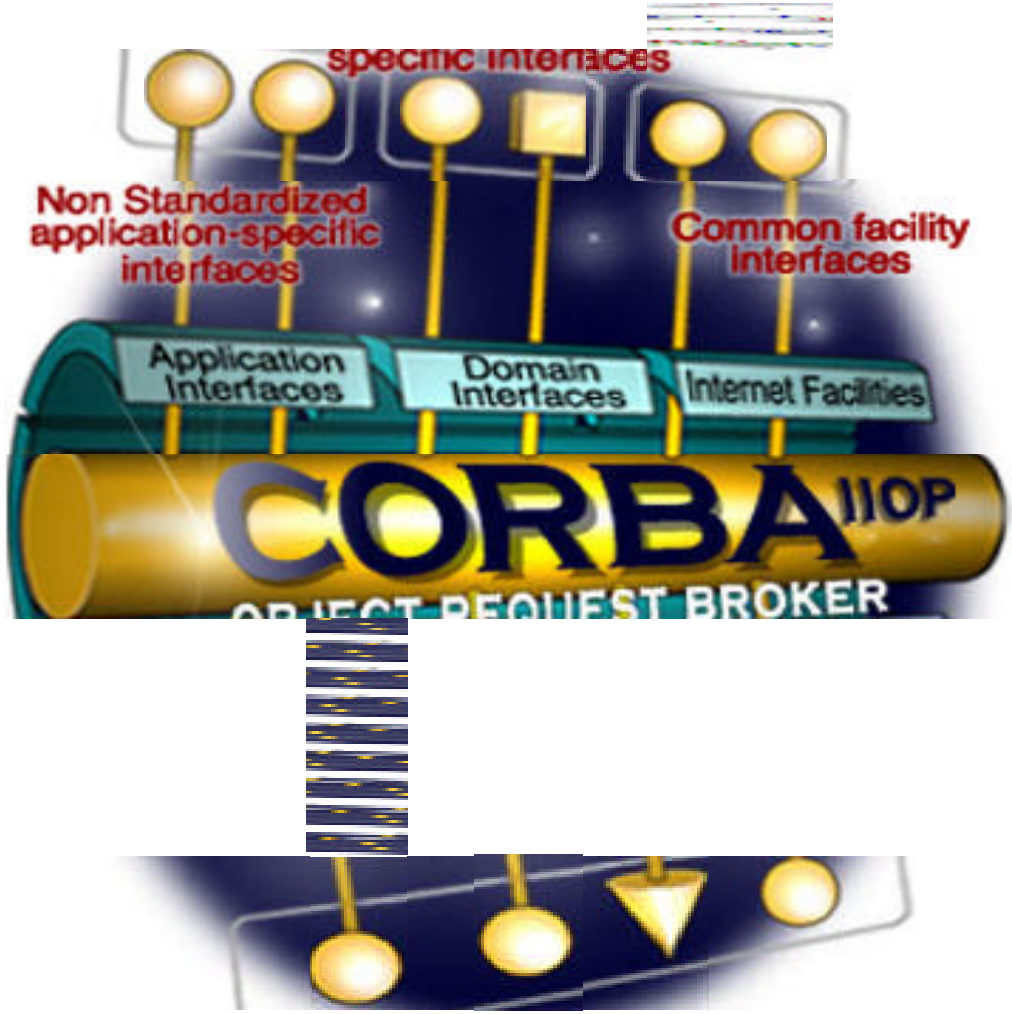
CORBA Offers an Answer



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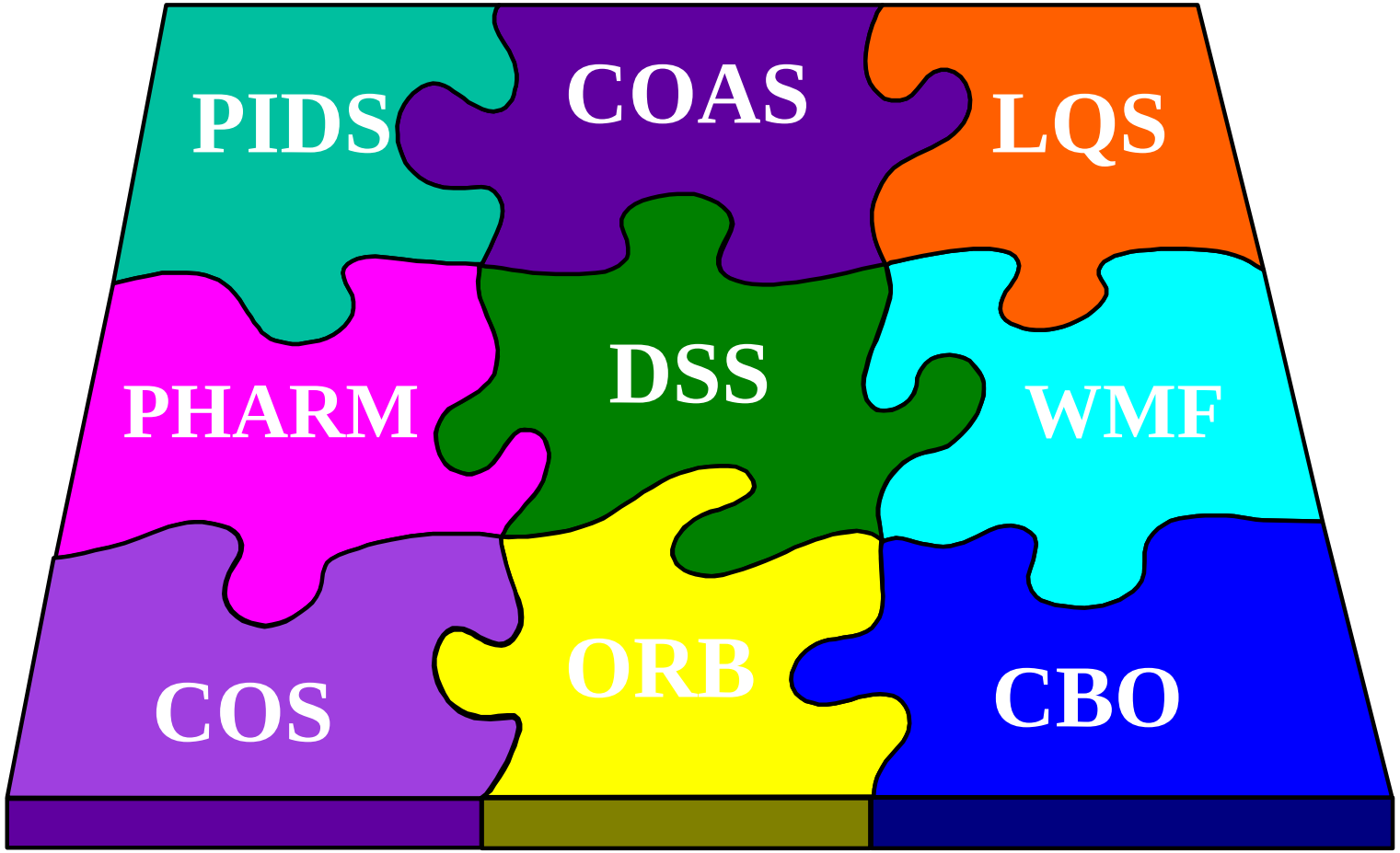
CORBA Offers the Pieces



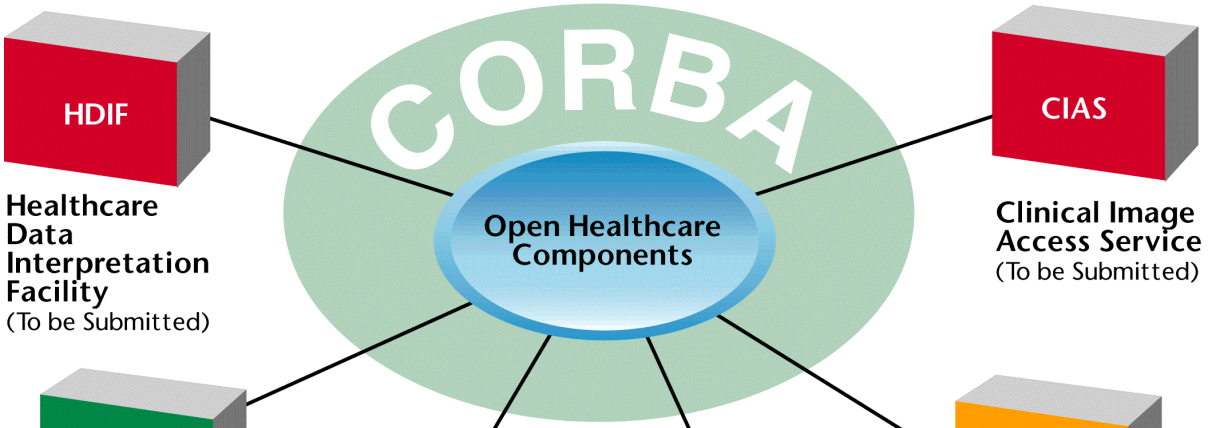
The Global Context

Personal Medical Record should
be securely accessible anywhere in the world

CORBAMed Task Force: Developing a Component Strategy for Healthcare

- OMG's Healthcare Initiative
- Have already issued a number of RFPs to standardize services and approved standards
- Have already gained significant exposure and support from healthcare software vendors and healthcare providers

CORBAmed: Industry Cooperating for the Future



HDIF

Healthcare Data Interpretation Facility
(To be Submitted)

CIAS

Clinical Image Access Service
(To be Submitted)

COAS

Clinical Observation Access Service
- 3M
- Care Data Systems
- CareFlow Net
- HBO & Co.
- Phillips Medical Systems,
- Protocol Systems,
- Sunquest

PIDS

Person Identification Service
- 2AB
- Care Data Systems
- HBO & Co.
- Health magic
- HUBlink
- IDX
- Iona
- Oacis
- Protocol Systems
- Sholink

HRAC

Healthcare Resource Access Control
(Submitted)
- 2AB
- Baptist Health Systems of South Florida
- CareFlow Net.
- IBM

LQS

Lexical Query Service
(Terminology Server)
- 3M
- Protocol Systems

Finalized Submitted To be Submitted

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CORBAmed objectives

Hardware industry-like performance coming to healthcare software industry: double the functionality at half the price, every year!

10/97 AMIA: National Health Information Strategy

- Universal Access
- Telemedicine and Tele-education
- Computer-based health records
- Decision-support systems.
- Standards development
- Confidentiality and Security
- Research, education, and development
- International Collaboration

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EMR Major Issues

- **Security**
  - privacy/confidentiality
  - information integrity
  - non-repudiation
  - ownership
  - Policy
- **Content**
  - what information should be available?
  - how does one link heterogeneous systems together?
- **Management/data archiving**
  - How much information should be available?
  - Is a “longitudinal patient record” feasible?
  - What is the cost?

EMR Requirements

- **Scalable**
  - from personal to large scale, distributed servers in a cost-effective manner (cpu and network)
- **Portable**
  - Record can be moved around without loss of information
- **Interoperable**
  - records can be exchanged between providers
  - records can be accessed and linked from/to others both inside and outside the military
- **Accessible**
  - Can be used with variety of network access speeds and connectivity from low-speed wireless to terabits as appropriate

TeleMed is Using CORBA to Integrate Across Healthcare Enterprises

- Standards-based (CORBA/Interoperable, Java, Java DataBase Connection, Object Data Mgt Grp)
- Distributed multimedia database
- Scalable/Extensible
- Web-accessible
- CORBA-based security with private/public key and point-to-point encryption

TeleMed Project

- **Goal: Give healthcare providers, and ultimately consumers, easy access to information from multiple healthcare encounters for collaborative health management**
- **Help create the interface standards within CORBAmed for widespread use**
- **Support DoD needs for widely accessible electronic medical records with scalable, sustainable technology**
- ***Security is critical!***
- ***Objects are* fundamental**

TeleMed Principles

- Move data only as necessary
- Manage complex high-volume data in understandable manner
- Same system for real-time consultations as for asynchronous consultations
- Leverage and enhance internet standards (e.g., OMG)
- Design for intuitive ease of use in clinical setting
- Plug-and-play design

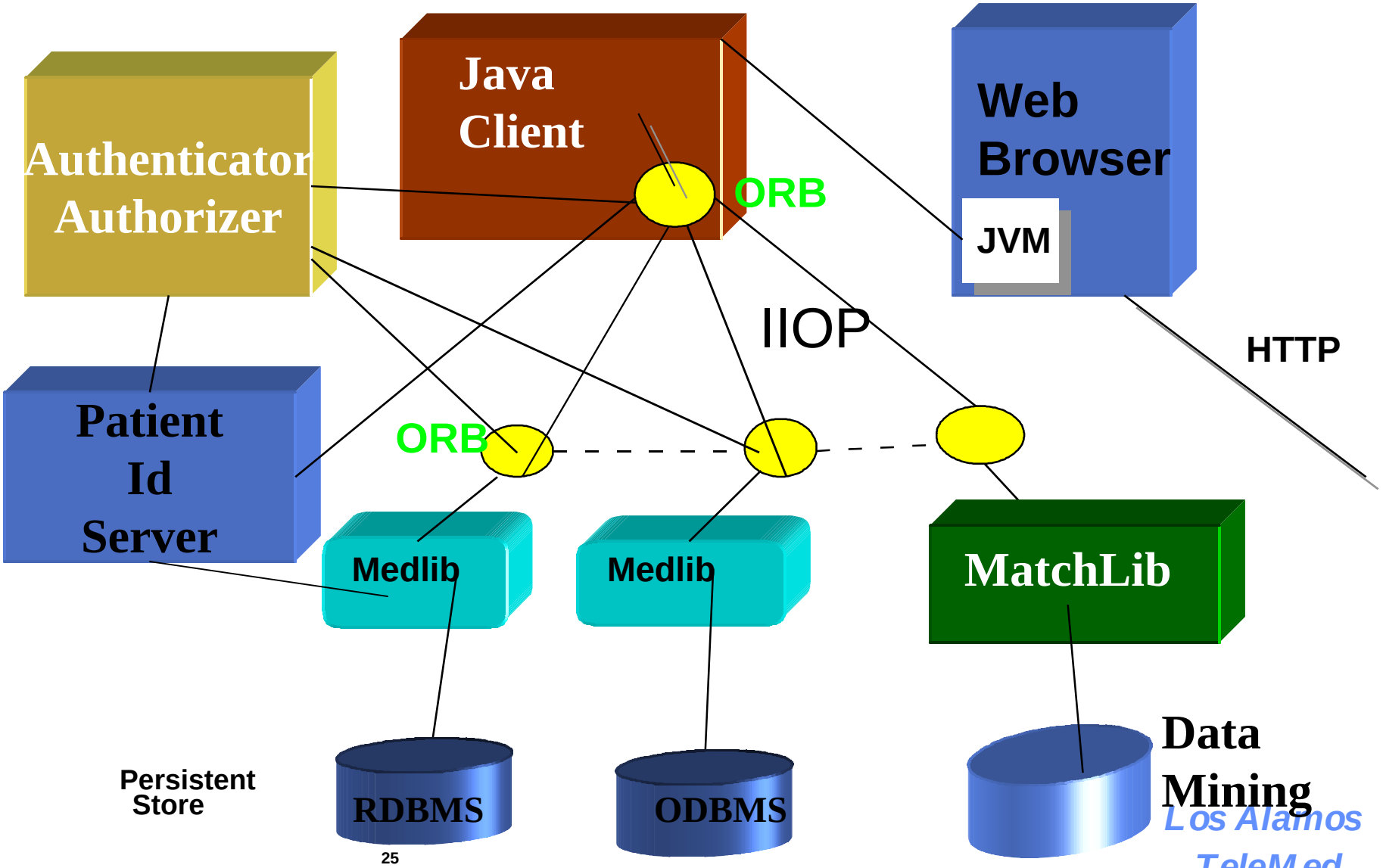
Current TeleMed Environment

- Security: Authentication and Authorization with public/private key and SSL support
- Early deployment in New Mexico
- Edit and sign various medical reports using user's credentials.
- Sound, image, html and various mime types of attachments included
- Immunization data supported
- Verified portability to Personal Information Carrier
- Assessing ability to integrate teledentistry and teledermatology teleconsulting systems.
- Working with Object Management Group to create distributed object standards in healthcare

Additional Tasks

- Federated Person Identification to link multiple sites and enterprises (state, DoD, …)
  - Trader service used
- Security policy management tools
- Support the context needed for consults
  - Additional modalities, drug capabilities, audio, ...
- Auto update of TeleMed client
- Rapid integration of existing RDBMS
- Adoption of Clinical Observation Access Service and Healthcare Resource Access Control Service
- Data mining capabilities (HDIF)
- Volume visualization

TeleMed Architecture



Patient IDentification Service

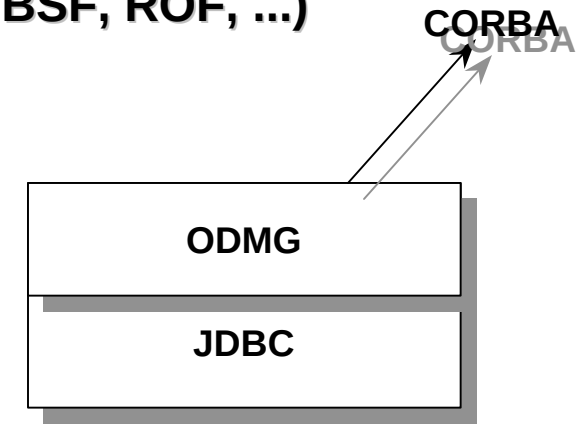
- Standard has been adopted (2/12/98) for managing patient identification across enterprise and beyond.
- Was demonstrated with multiple vendors and platforms at HIMSS ’98.
- Provides for multiple communicating domains, correlation management including merging and un-merging patient identifiers
- Extensible traits with first implementation on HL7 and vCard (including sound and photos)
- Secure implementation: no IDL changes
- Federated servers for wide-area linkage

Java + CORBA

- Enables robust, scalable electronic medical record
- Multi-tiered architecture support
- Easy to distribute client software
- Flexible interface
- Collaborative tools and support for distributed event management
- Java Beans Interoperable Components
- Portable Servers

Pure Java on the Server

- Portability of server code very important
- Layered approach:
  - ODMG Java bindings (e.g., portable by O_2 and Poet to RDBMS)
  - JDBC standard interface to RDBMS
  - Map persistent objects to CORBA objects
  - Tools to automap between Java and Relational tables (e.g., Java Data Exchange, JavaBlend, VBSF, ROF, ...)
- Performance an issue
  - JIT compilers major benefit
  - Performance is adequate today
  - Scalability is still an issue



Security Requirements

- Critical: authentication and application-level authorization at the server
- Required: object-level authorization and confidentiality
- Any passwords sent from the client to the server for authentication must be encrypted
- Single logon desirable
- Commercial CORBASecurity solution preferred for TeleMed

TeleMed Security Model

Provide capability for authentication and authorization to view distributed data

- **Secure data at object level, allow policy to drive security deployment**
- **Use public/private key with point-to-point encryption**
- **Client security managed with inexpensive but robust hardware: iButton**

TeleMed Security

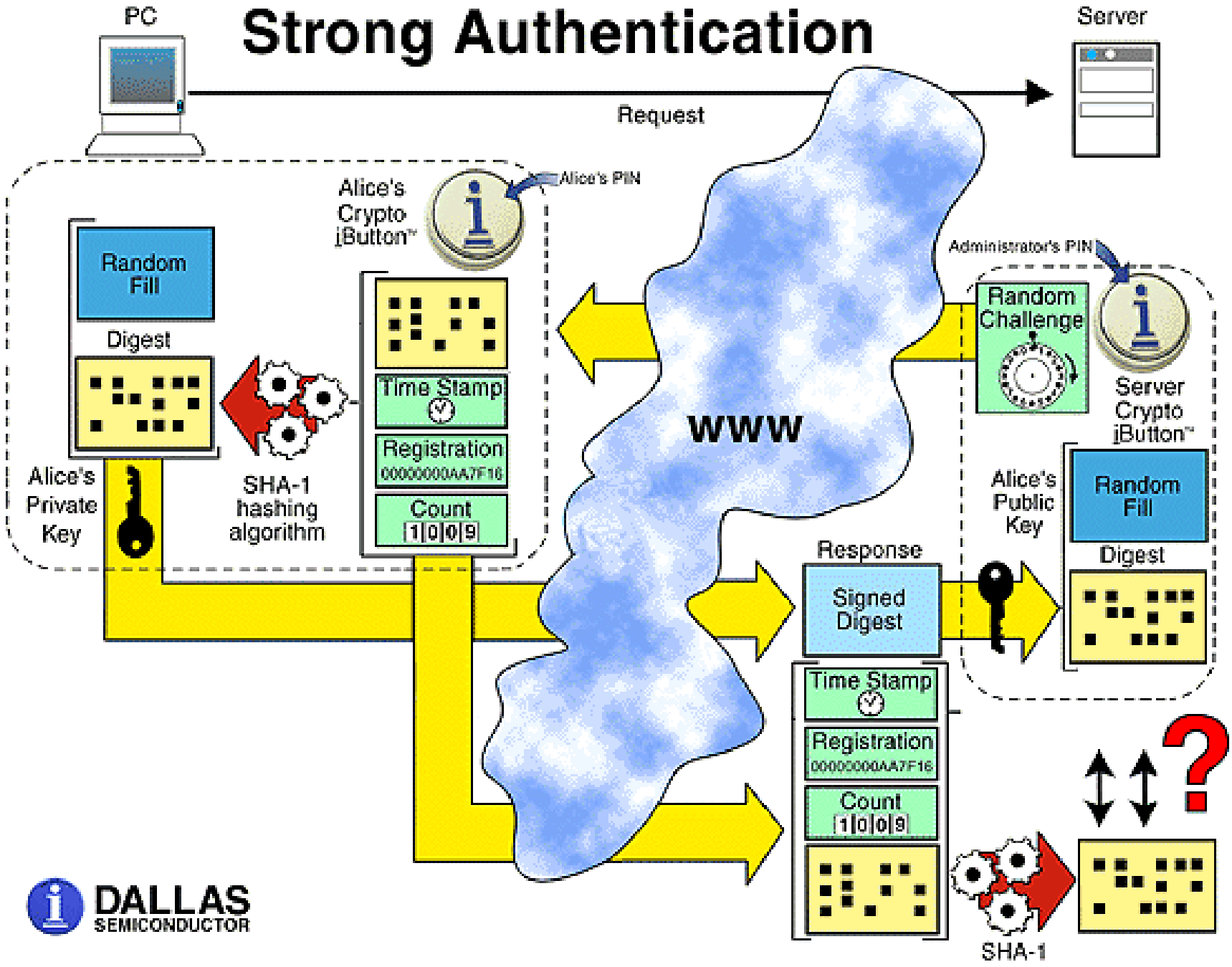
- **Authentication server**
  - Uses Public Key Infrastructure (PKI) technology to validate client and server using Dallas Semiconductor's iButton (also via software)
  - Secret symmetric key exchanged between authenticator and client
  - Encrypted credentials on ORB principal of client
- **Application Server**
  - Server also authenticates itself to Authentication server
  - Checks client credentials with authentication server
  - Any necessary data (e.g., patient-identifiable) is encrypted between client and server (may use a Virtual Private Network "VPN")

TeleMed Security

- PKI is used to transmit “role” password to Authentication/Authorization server for validation
- Policy query called on each server method
  - no interceptor standard
  - local caching for performance with additional checks
- Java Cryptographic Extension (JCE 1.2)
- Objects selectively encrypted or run with SSL

Robust client security

- Windows 95 insecure!
- Inadequate for managing private keys
- Use Cryptographically-secure iButton to manage private key
- Provide user-friendly, high level security at low cost
- Integrate with CORBAsecurity


Strong Authentication
PC
Server
Request
Alice's PIN
Alice's Crypto iButton™
Random Fill
Digest
Time Stamp
Registration
00000000AA7F16
Count
1 0 0 9
Alice's Private Key
SHA-1 hashing algorithm
WWW
Administrator's PIN
Random Challenge
Server Crypto iButton™
Alice's Public Key
Random Fill
Digest
Response
Signed Digest
Time Stamp
Registration
00000000AA7F16
Count
1 0 0 9
SHA-1
DALLAS SEMICONDUCTOR

Clinical Use of TeleMed

- Test at NJC for management of chronic mycobacterial disease
  - Review data for new patients referred to NJC
  - Prepare for follow up visits
  - Advise physicians at remote sites
- System designed around needs of physician
- Integrates patient history, Lab studies, drug treatments, various reports, image studies, and text/audio annotations in a longitudinal record

Northern NM Rural Telemedicine Project

- NTIA (TIIAP Grant to Northern NM Community College, Espanola ($500K over 2 years) + Match
- 16 Rural Clinics from
  - Health Care Centers of Northern New Mexico
  - Las Clinicas del Norte
- Regional Hospitals
  - Espanola Hospital and Los Alamos Medical Center
- Commercial Partners:
  - Intel, FileNet, Hublink, NM Dept of Health, Dallas Semiconductor, Citizen1, Information Assets, GSTI, …
- Comprehensive evaluation before and after deployment

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The Need

- **Rural clinics in Northern New Mexico**
  - sparsely populated
  - large distances separating clinics and hospitals
  - few resources for information management
- **Confused medical records**
  - same name, different patients
  - same patient, different names
  - same Social Security number, different patients
- **Repeated treatments for same condition**
  - lack of sharing between clinics
- **Referral slips do not arrive in time**
- **Continuing education for health care providers**

The Project

- **Create Electronic Medical Records**
  - **immunization records (also extend statewide)**
  - **prescriptions**
  - **allergies**
  - **patient encounters**
- **Share Records over the Internet with**
  - **confidentiality**
  - **security**
  - **surety**
- **Test and Validate first prototypes of a Master Patient Index**
  - **rural (northern New Mexico)**

The Project (cont.)

Evaluation and Validation

- **Comparison (before and after implementation)**
  - **number of patients with immunization records**
  - **number of patients with allergy records**
  - **instances of multiple patient records**
  - **number of lost records**
- **Subjective evaluations**
  - **time to enter records**
  - **communication with other clinics**
  - **access to medical information**
- **Job-task-analysis of affected jobs**

Job Task Analysis

- **Medical Record Keepers**
  - creating new patient records and processing patients
- **Providers**
  - documenting patient interactions
  - reviewing patient progress
  - view medical record as information source for analytical and decision making activities.
- **Design of TeleMed needs to meet both needs.**

Experiences

- Internet training needed for medical records and health care providers
- Bringing various partners to the table breaks down barriers
- Enthusiasm continues to be high
- Network is up at about 8 sites
- Feedback being obtained for the medical record and data input mechanisms
- Security is being tested and is near deployment

TeleMed Information

- **For more info:**
  http://www.acl.lanl.gov/TeleMed
- ***"An International Collaboratory based on Virtual Patient Records"* August 1997**
  Communications of the ACM